# Usages of Public Randomness

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## Public Randomness

**Goals:**

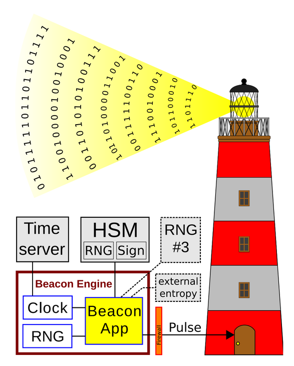
- Investigate the value of public randomness as a public good.
- Foster applications that use public randomness with the NIST format.

**Sources of public randomness:**

- Natural: earthquakes, solar storms, fire patterns, ..., quantum processes
- Social: lottery results, stock market prices, twitter feeds, ..., blockchains
- Custom: cryptographic **Randomness Beacons** (like the NIST Beacon)

## A Randomness Beacon

- Periodically publishes a randomness *pulse*
- Each pulse contains a fresh sequence of 512 random bits
- The pulses are indexed, have a time stamp and a digital signature
- Past pulses are publicly available
- The sequence of pulses forms a hash chain




NIST has a project about Interoperable Randomness Beacons, with four tracks:

A. **Beacons Reference:** promote a reference for randomness beacons;
B. **NIST Beacon:** maintain a NIST Beacon implementation;
C. **External beacons:** promote the deployment of other Beacons by multiple organizations;
D. **Uses of public randomness:** foster applications that use beacon-issued randomness.

This poster is about track D, with a focus on public auditability.

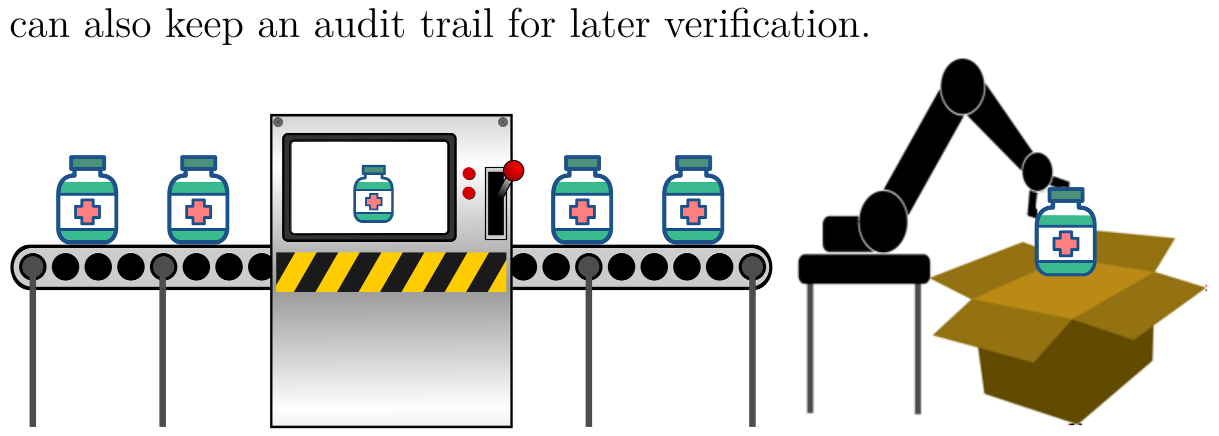
## Generic applications

### Public auditability

- **Setting:** You need to make a random choice from a set $\{C_1, \ldots, C_n\}$ of possibilities.
- **Challenge:** At a later time you would like to prove to a judge that all choices were equally likely when you made the selection.
- **Solution:** Cryptographic commitments, time stamps, and a public source of randomness are enough to solve your problem.

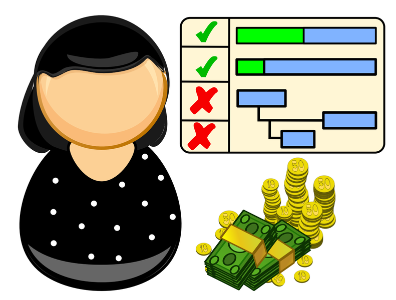
### Quality control

- **Setting:** Randomized sampling is used for quality control in manufacturing processes. The process can be compromised if the random samples are chosen by a worker in the factory floor (or insiders in general).
- **Application:** With public randomness, a phone app can instead do the sampling. The factory can also keep an audit trail for later verification.



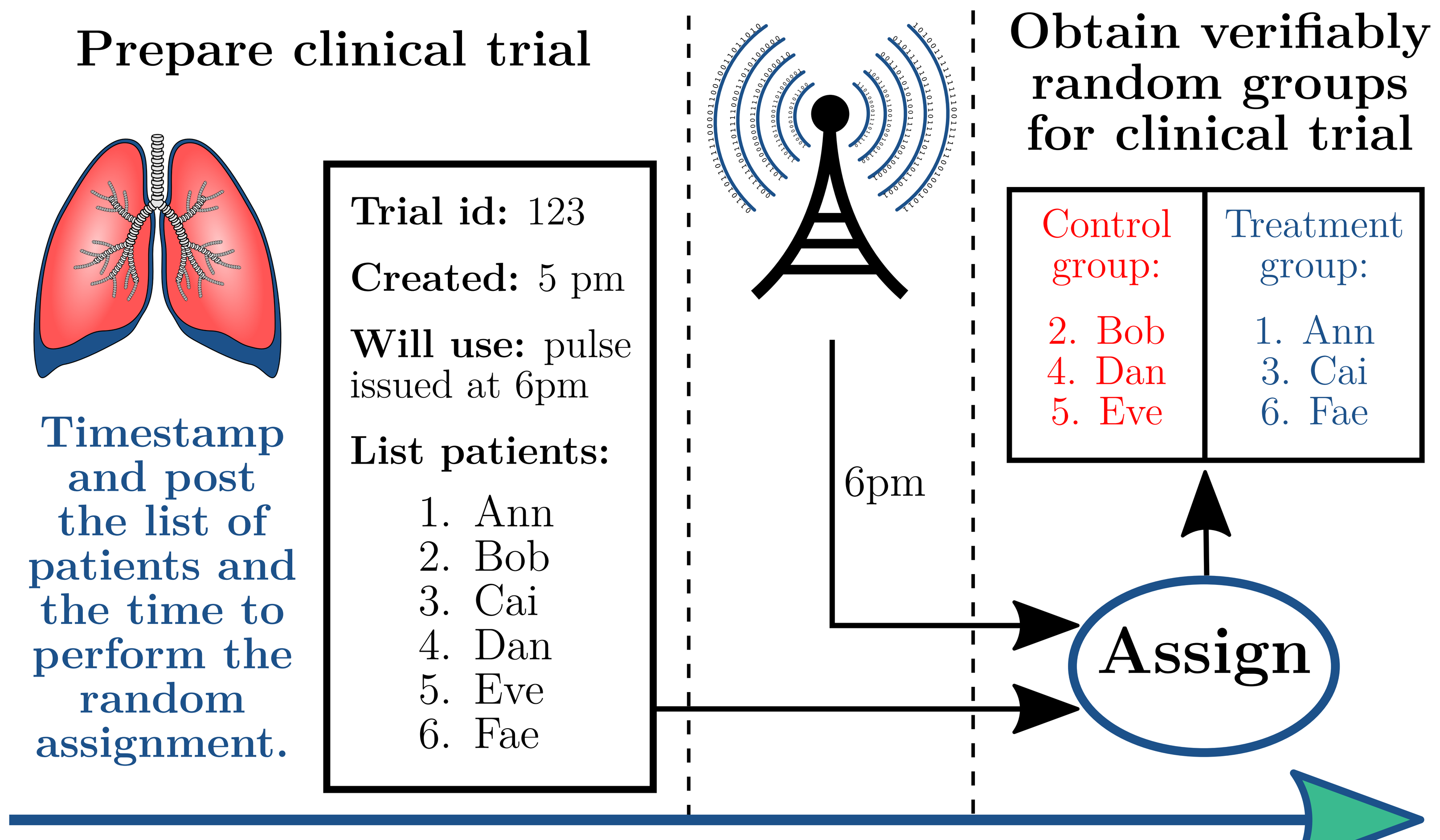
## Use-case 1: Random officials for financial audit

- **Setting:** The government of Chile **selects random** public officials for financial audits. Each official has a *risk score* based on public and private information (e.g., stock holdings of spouse). The probability of selection should be proportional to the risk score.
- **Challenge:** Enable **public auditability** of the selection, along with **privacy of the data** used to compute the score.
- **Solution:** Use public randomness from a **beacon** along with **zero-knowledge proofs**. Note: Chile has implemented a Beacon following the NIST reference for randomness beacons.



## Use-case 2: Randomized clinical trials

- **Example setting:** a placebo-controlled clinical trial assigns patients to either the **treatment** group or the **control** group.
- **Goal:** After the study, it is possible to convince others that the trial was properly randomized.


Time flow of a clinical trial protected by the Beacon

## Others example use-cases

### Random judges for court cases

- For years, New Orleans has been struggling with a problem referred to as *forum shopping*: prosecutors were being accused of gaming the court system so as to have friendly judges assigned to certain cases.
- The Criminal District Court judges saw it useful to implement random assignment of judges to cases. Real-life constraints makes this a non-trivial problem. NIST could help if we get a full specification of the problem.

### Eliminating bias in randomized security checks

- **Setting:** "You have been randomly chosen for additional security screening."
- **Goal:** Allow individuals to confirm that the selection was really random.

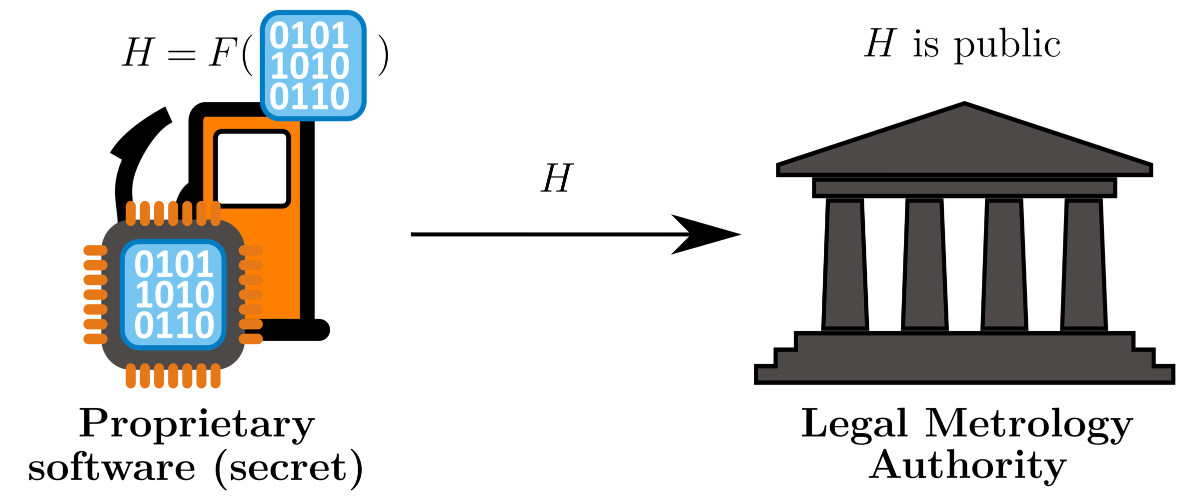
## Use-case 3: Legal metrology

An application motivated by INMETRO (Brazil), using a Beacon with the NIST reference

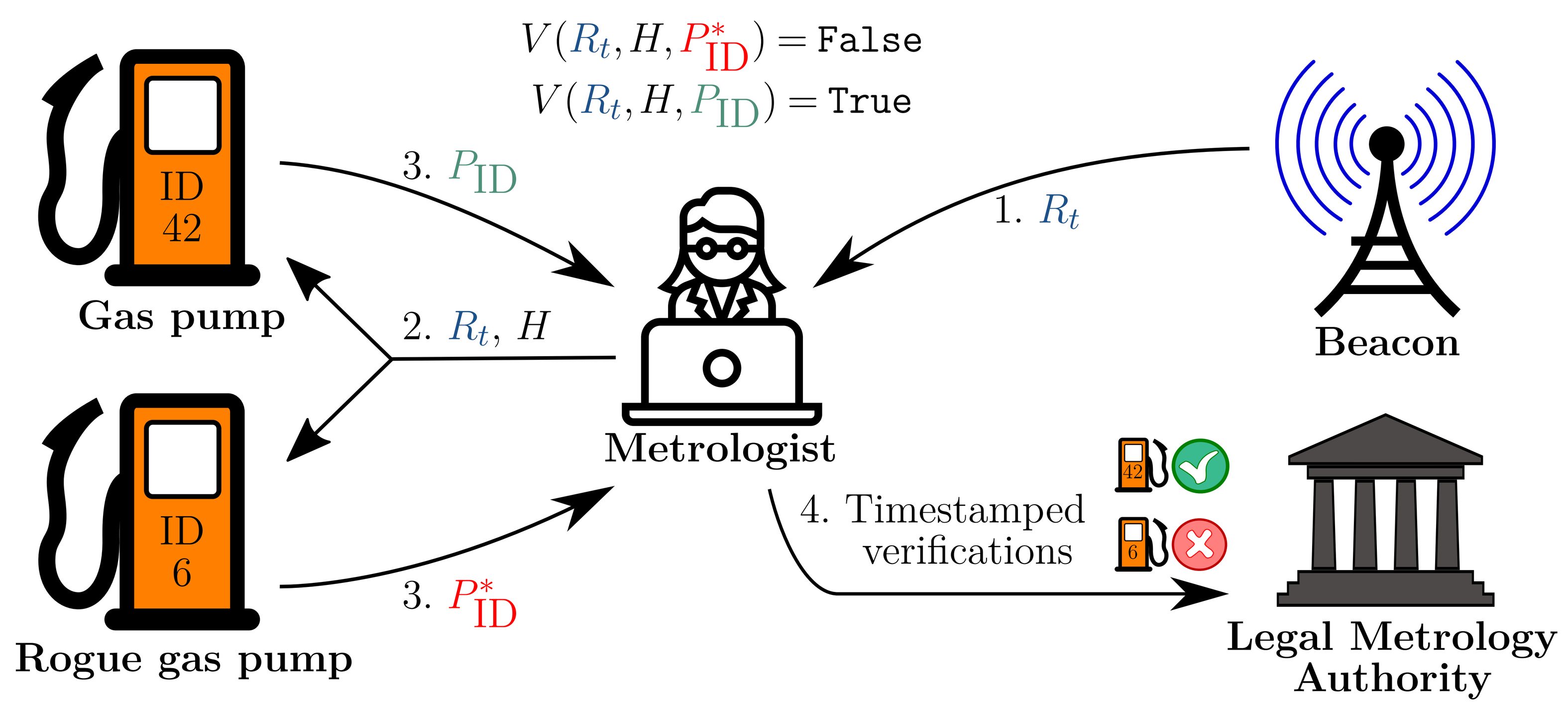
- **Goal:** Improve metrological inspections through public randomness
- **Challenge:** Gas pumps and other instruments are subject to malicious firmware replacement and counterfeits
- **Solution:** Authentication checks using public randomness for metrological verifications

### The Protocol

- **Model Registration:** The metrology authority registers the approved gas pump model and publishes the digital fingerprint (hash $H$) of its **secret software**. The hash $H$ is obtained through a function $F$ that takes the software (binary code) as input.

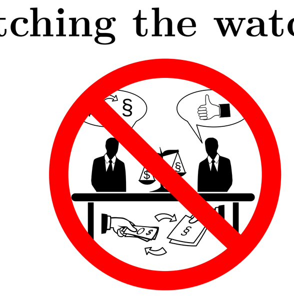



- **Device Inspection.** The metrologist sends to each pump the timestamped Randomness Beacon pulse $R_t$ and the hash $H$. An honest pump can produce a verifiable proof $P_{\text{ID}}$ while a rogue one cannot. The inspection results are sent to the legal metrology authority.



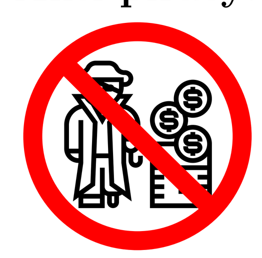

### The Benefits

**Watching the watchers:**



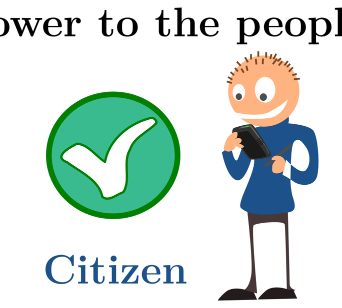
The legal metrology authority can use $(R_t, H, P_{\text{ID}})$ to spot malicious metrologists.

**Anti piracy:**



Counterfeits without the proprietary software cannot construct the proof $P_{\text{ID}}$.

**Power to the people:**




Any citizen can use the randomness beacon to check that a pump has the correct software.

**The Interoperable Randomness Beacons Project:** beacon@nist.gov

**Webpage:** `https://csrc.nist.gov/Projects/Interoperable-Randomness-Beacons`

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